

Building on 50 Years of Mission Operations Experience for a New Era of Space Exploration

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Abstract

The U.S. National Space Policy,¹ the 14-nation Global Exploration Strategy,² and the National Aeronautics and Space Administration's (NASA) 2006 Strategic Plan³ provide foundational direction for far-ranging missions, from safely flying the Space Shuttle and completing construction of the International Space Station by 2010, to fielding a next generation space transportation system consisting of the Ares I Crew Launch Vehicle/Orion Crew Exploration Vehicle and the Ares V Cargo Launch Vehicle/Altair Lunar Lander (fig. 1). Transportation beyond low-Earth orbit will open the frontier for a lunar outpost, where astronauts will harness *in-situ* resources while exploring this 4 billion-year-old archaeological site, which may hold answers to how the Earth and its satellite were formed. Ultimately, this experience will pave the way for the first human footprint on Mars.



Fig. 1. NASA concept of the Ares I/Orion (right) and the Ares V.

In October 2007, NASA announced assignments for this lunar exploration work.⁴ The Marshall Space Flight Center is responsible for designing, developing, testing, and evaluating the Ares I and Ares V, which are Space Shuttle derived launch vehicles, along with a number of lunar tasks. The Marshall Center's Engineering Directorate provides the skilled workforce and unique manufacturing, testing, and operational infrastructure needed to deliver space transportation solutions that meet the requirements stated in the Constellation Architecture Requirements Document (CARD). While defining design reference missions to the Station and the Moon, the CARD includes goals that include reducing recurring and nonrecurring costs, while increasing safety and reliability. For this reason, future systems are being designed with operability considerations and lifecycle expenses as independent variables in engineering trade studies.

Within Marshall's Engineering Directorate, the Mission Operations Laboratory team has been integral to NASA's missions from the earliest days of U.S. spaceflight to current International Space Station science operations. This paper will give a brief history relative to NASA's 50th anniversary and provide top-level information about involvement in current Shuttle and Station missions, as well as the design and development work in progress for a number of exploration-related initiatives. For example, the Ares I Operational Concepts Document has been developed by Mission Operations personnel in partnership with the Mission Operations Directorate at the Johnson Space Center and the launch services provider at the Kennedy Space Center to address such challenges as developing ground support equipment, documenting work flow, reducing the logistics footprint, and adopting streamlined concepts such as those followed for expendable launch vehicles. Creating appropriate handoffs from development engineering to operations functions is one of many decisions to be made relative to fielding a new space transportation system.

When performing analytical studies to improve the turnaround time for the new system, technical metrics are balanced with programmatic cost and schedule targets. One outcome has been the decision to mate the J-2X engine in the upper stage prior to shipping to the launch site. Another innovation has been to develop a full-scale mockup of the Ares I upper stage instrument unit ring, which provides guidance and control and other avionics functions to the craft, and the interstage structure, complete with low-fidelity engine mold line. This serves as physical mockup for laying out components and testing ground support equipment concepts, translating them from two-dimensional computer aided modeling and simulation to three-dimensional structures. This simulator is being used by design engineers and operators to make decisions that ultimately will affect the lifecycle costs of the Ares I.



Fig 2. The Ares I instrument unit/interstage simulator is located at Marshall's Propulsion Research Development Laboratory.

With over 6 years of experience working with international crews on the Space Station and corresponding scientists on Earth, the Mission Operations Lab has the talent, facilities, protocols, and distributed network in place to conduct operations 24 hours a day/7 days a week in the Payload Operations Center (fig. 3). This capability builds on decades of experience monitoring Shuttle propulsion elements during launch and working with crewmembers to conduct real-time hands-on Skylab and Spacelab microgravity science missions. Services include procedures and timeline development along with crew training, as well as coordinating payload activities for the Station's international partners, including the Russian Space Agency, European Space Agency, National Space Development Agency of Japan, and Canadian Space Agency.⁵ Planning for future missions beyond low-Earth orbit, Marshall's Mission Operations works closely with the Mission Operations Directorate and with Launch Operations to find innovative ways to reduce the new space transportation system's operational footprint across the board by building on the knowledge, experience, infrastructure, and resources resident in each, while providing the integration for international scientific cooperation. Through this approach, NASA and its industry partners are addressing and identifying long-term solutions for sustainable space exploration.



Fig. 3. Marshall's Mission Operations Laboratory monitors Shuttle propulsion elements during launch and provides scientific support for Station science operations.

References

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